Problem:

(4) A flat slab of dielectrics with relative permittivity 5 is placed normal to a uniform field of flux density $2\ C/m^2$. The slab occupies a volume of $0.1\ m^3$ and is uniformly polarized. Find (i) Polarization (ii) dipole moment of the slab.

Given:

$$\varepsilon_r = 5, \quad D = 2\ C/m^2, \quad v = 0.1\ m^3$$

To find: (i) $P = ?$

$$D = \varepsilon_0 E + P$$

$$P = D - \varepsilon_0 E$$

$$P = D - \varepsilon_0 \frac{D}{\varepsilon_0 \varepsilon_r}$$

$$P = D - \frac{D}{\varepsilon_r}$$

$$P = D\left[1 - \frac{1}{\varepsilon_r}\right]$$

$$P = 2\left[1 - \frac{1}{5}\right] = 1.6\ C/m^2 = P$$

$$D = \varepsilon E$$

$$D = \varepsilon_0 \varepsilon_r E$$

$$E = D/\varepsilon_0 \varepsilon_r.$$

(ii) Relation btw Polarization intensity & dipole moment

$$P = \frac{\text{total dipole moment}}{\text{volume.}}$$

$$1.6 = \frac{\text{total dipole moment}}{\text{volume}}$$

dipole moment = 1.6×0.1

dipole moment = 0.16 cm.

(2) Given. $\varepsilon_r = 4$ $D = 1.5\ C/m^2$ $V = 0.08\ m^3$

To find $P = ?$ $P = ?$

$P = ?$

$D = \varepsilon_0 E + P$

$P = D - \varepsilon_0 E$

$P = D - \varepsilon_0 \frac{D}{\varepsilon_r}$

$P = D - \frac{D}{\varepsilon_r}$

$P = D\left[1 - \frac{1}{\varepsilon_r}\right]$

$P = 1.5\left[1 - \frac{1}{4}\right]$

$= 0.75 \times 1.5$

$P = 1.125\ cm^2$

$$P = \frac{\text{total dipole moment}}{\text{volume.}}$$

$$1.125 = \frac{\text{Total dipole moment}}{0.08}$$

total dipole moment = 1.125×0.08

dipolemoment = 0.09 C-m